US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
Total Environmental Restoration Contract
USACE CONTRACT NUMBER: DACW33-03-D-0006
Task Order No. 0007

EVALUATION OF THE IMPACT OF DREDGING AND CAD CELL DISPOSAL ON AIR QUALITY

NEW BEDFORD HARBOR SUPERFUND SITE, NEW BEDFORD, MA

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New Bedford Harbor Superfund Site
New Bedford, MA

January 2010

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ACE-J23-35BG0702-M17-0005

TABLE OF CONTENTS

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TABLE OF CONTENTS

Figures

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Tables

Appendices

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ACRONYMS AND ABBREVIATIONS

CAD	confined aquatic disposal
City	City of New Bedford
cy	cubic yards
EPA	U.S. Environmental Protection Agency
FW	Foster Wheeler Environmental Corporation
ISC3	Industrial Source Complex Model
ISCLT3	Long Term Industrial Source Complex Model
ISCST3	Short Term Industrial Source Complex Model
Jacobs	Jacobs Engineering Group, Inc.
LHCC	Lower Harbor CAD Cell
MU	management unit
NAE	U.S. Army Corps of Engineers – New England District
NBH Site	New Bedford Harbor Superfund Site
ng/m^3	nanograms per cubic meter
PCB	polychlorinated biphenyl
ppm	parts per million
UDM	unsuitable dredged materials

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1.0 INTRODUCTION

This report describes the air modeling investigation for the dredging, transport, and disposal activities associated with the proposed lower harbor confined aquatic disposal (CAD) cell (LHCC) at the New Bedford Harbor Superfund Site in New Bedford, Massachusetts (NBH Site). For the purposes of this modeling effort, and to represent high dredging and disposal rates, the draft April 2009 cost estimate titled *Alternative #4 Hybrid at $80M/Year* (Alternative #4 Hybrid) was used for activity sequence, sediment removal rates, and project duration (Jacobs, 2009a). Polychlorinated biphenyl (PCB) concentrations were obtained from the *Air Dispersion Modeling of 2009 Dredging Operations* (Jacobs 2009b). For *Alternative #4 Hybrid at $80M/Year*, years four and five will involve placement of PCB-contaminated material into the LHCC (Jacobs 2009a).

Removal of PCB-contaminated sediments in the harbor was the remedial action selected for the NBH Site. The current approach consists of hydraulic dredging, desanding and dewatering of dredged sediments, treatment of the wastewater generated in the dewatering process, and disposal of desanded and dewatered sediment at an approved landfill. The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers – New England District (NAE) are considering use of an LHCC to shorten the remediation timeframe and lower the overall harbor remediation cost. The investigation documented by this report evaluates the impact to air quality from the proposed CAD cell disposal activity.

CAD is the process where dredged material that is unsuitable for unconfined open water disposal is deposited into a marine environment within a confined area or excavation, and then capped with a suitable material. CAD cells are increasingly becoming the selected option for the management of unsuitable dredged material (UDM).

The sediments slated for the proposed LHCC are the relatively lower PCB-contaminated sediments from approximately the Sawyer Street area south to the Route 6 bridge. Air dispersion modeling was conducted to estimate the air quality impacts of mechanically dredging, transporting by scow, and disposing these sediments into the proposed LHCC.

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Deleted: There are basically two methods of constructing a CAD site. Most commonly, CAD sites are created by placing unsuitable material on the existing seabed, and then covering it with material that is suitable for open-water disposal. The overlying layer is commonly referred to as a cap, typically constructed from either dredged silt or sand. This method has been used in open-water disposal sites in New England, New York, and elsewhere; and requires that sufficient suitable material be available to provide complete capping of unsuitable dredged materials (UDM). The second method of constructing a CAD site is to excavate a pit or cell, which is then filled with UDM and capped with a suitable material. In general, these sites can be created in shallower water, but require water depths in excess of 20 feet (6.1 m), so that dredges and barges, which are used to create and fill the cell, can access the area. ¶

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This study is the continuation of the 2005-2009 air modeling efforts (Jacobs 2005, 2006, 2007, 2008, and 2009b) incorporating the latest site-specific meteorological data.

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2.0 BACKGROUND

2.1 SITE INFORMATION

The NBH Site is located in Bristol County, Massachusetts, approximately 55 miles south of Boston, and is bordered by the Towns of Acushnet, Fairhaven, and North Fairhaven on the east side of NBH, and by the City of New Bedford (City) on the west. From north to south, the NBH Site extends from the upper reaches of the Acushnet River estuary, through New Bedford's commercial port, and into Buzzards Bay (Figure 1).

Industrial and urban activities surrounding the NBH Site have resulted in sediments becoming contaminated with PCBs and heavy metals, with concentration gradients generally decreasing from north to south. PCB-contaminated sediments and seafood in and around New Bedford Harbor were first identified in the mid-1970s as a result of EPA region-wide sampling programs. Based on these sampling programs, the principle sources of PCB contamination were determined from two electric capacitor manufacturing facilities located adjacent to the Acushnet River/New Bedford Harbor water way. The Aerovox facility was the primary source of PCB contamination and was located near the northern boundary of the site. PCB wastes were discharged from Aerovox's operations directly into the Upper Harbor through open trenches and discharge pipes, or indirectly throughout the site via the City's sewage system. Additional inputs of PCBs were also made from the Cornell Dubilier Electronics, Inc. facility just south of the New Bedford Hurricane Barrier. PCB use at these electric capacitor manufacturing facilities occurred from the 1940s into the 1970s. The NBH Site was added to the Superfund National Priorities List (NPL) in September 1983.

The NBH Site has been divided into three areas - the Upper Harbor, the Lower Harbor, and the Outer Harbor - consistent with geographical features of the area and gradients of contamination (Figure 1). The Upper Harbor, above the Interstate-195 Bridge, comprises approximately 187 acres, with a wide range of PCB concentrations in sediments [below detection to approximately 10,000 parts per million (ppm)]. Prior to the removal of the most contaminated hot spot sediments in 1994 and 1995 as part of the NBH Site's first

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cleanup phase, sediment PCB levels were reported higher than 100,000 ppm at isolated locations in the Upper Harbor. The Lower Harbor, from the interstate bridge to the hurricane barrier, comprises approximately 750 acres. In portions of the Lower Harbor, sediment PCB levels range from below detection to over 100 ppm. Sediment PCB levels in the Outer Harbor are generally low, with only localized areas of PCBs in the 50 to 100 ppm range near the Cornell-Dubilier plant and the City's sewage treatment plant outfall pipes.

Remedial action at the NBH Site is currently being completed by Jacobs Engineering Group, Inc. (Jacobs) under a Total Environmental Restoration Contract (TERC) from NAE.

2.2 DREDGING AND CAD CELL DESIGN

Since 2004, several of the highly contaminated management units (MU) have been hydraulically dredged. Alternative #4-Hybrid includes a five-year dredging plan that incorporates hydraulic dredging and off-site disposal for the first three years and mechanical dredging and LHCC disposal for the last two years. It is these last two years that are the subject of this air modeling investigation.

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Figure 2 shows the distribution of PCB contaminated sediments in the harbor, assigned MU numbers, and their dredging composite areas. Table 1 lists the MUs and their dredging concentrations, volumes, and relative time frames.

The proposed CAD cell disposal and associated dredging areas are all located in the lower part of the Upper Harbor (Composite Area 4) and Lower Harbor (Composite Area 5) of the NBH Site (Figure 2). The sediment from these areas would be dredged using a mechanical dredging bucket to an open top barge to transport to the CAD cell.

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The proposed LHCC would be sited south of the Route 195 bridge and north of Popes Island (Figure 2). The cell would have a design capacity of about 300,000 cubic yards (cy) to accommodate the dredging volume. An engineered excavation would be created

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and filled with sediment dredged from an area stretching from Sawyer Street south to the Route 6 bridge. It is assumed that an open top scow would be towed to the CAD cell, and that the dredged sediment would be placed into the LHCC by either a) opening a split-hull scow or b) using a clam shell bucket. After the CAD is filled to its design depth, a cover of clean sandy material would be placed to prevent contact with aquatic life and to prevent migration of contaminants out of the cell. Figure 3 shows the planned dredging scenarios and the assumed LHCC location.

2.3 PREVIOUS EMISSION CALCULATIONS AND AIR DISPERSION MODELING

Mechanical dredging, transport, and CAD cell disposal operations have the potential to expose the sediments to the open air for limited periods of time. As a consequence, vapor phase PCBs, especially lighter, lower molecular weight PCBs, could be released into the atmosphere. These releases would be in addition to on-going "natural" PCB emissions from the Site's contaminated sediments, especially from contaminated mudflats exposed to open air at low tide.

Air dispersion modeling activities have been conducted by Foster Wheeler Environmental Corporation (FW) (2001) and Jacobs (2005, 2006, 2007, 2008, 2009b). Both FW and Jacobs performed air dispersion modeling using the Industrial Source Complex Model (ISC3) code (EPA 1995a, b) to estimate the air concentrations of PCBs generated by dredging and treatment facilities for the current remedial dredging activity (i.e., dredging, desanding, dewatering and offsite disposal). Since 2005, Jacobs has utilized time-specific dredging data and on-site meteorological data to model and estimate the air quality impacts from the dredging operations (Jacobs 2005, 2006, 2007, 2008, and 2009b). Air quality monitoring data over the past five years has also been used to substantiate the model assumptions and input parameters. This is done to improve the accuracy of the model predictions.

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3.0 AIR DISPERSION MODELING

This section describes the assumptions and input parameter selections used for the proposed dredging and CAD activity air modeling investigation.

3.1 ISC3 MODEL

The ISC3 used for the air dispersion modeling efforts is a steady-state Gaussian plume model that can be used to assess pollutant concentrations from a wide variety of sources associated with industrial and environmental activities. ISC3 models are specifically designed to support the EPA's regulatory modeling programs.

The ISC3 model can be operated in both long-term (ISCLT3) and short-term (ISCST3) modes. The ISCST3 model utilizes hourly meteorological data to model emissions for a given period. The ISCLT3 model is only used to model emissions with long-term averaging periods by utilizing standard stability array meteorological data. The ISC3 model is capable of handling multiple sources; including point, volume, area, and open pit source types. Line sources may also be modeled as a string of volume sources or as elongated area sources. Several source groups may be specified in a single run, with the source contributions combined for each group. The model also contains algorithms for modeling the effects of aerodynamic downwash due to nearby buildings on point source emissions, and algorithms for modeling the effects of settling and removal (through dry deposition) of particulates. The model user may select either rural or urban dispersion parameters, depending on the characteristics of the source location.

Source emission rates can be treated as constant throughout the modeling period, or may be varied by month, season, hour-of-day, or other periods. These variable emission rate factors may be specified for a single source or for a group of sources. For the ISCST3 model, the user may also specify separate, hourly emission rates for some or all of the sources included in a particular model run.

The ISCST3 model accepts hourly meteorological data records to define the conditions for plume rise, transport, diffusion, and deposition. The model estimates the

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concentration or deposition value for each source and receptor combination for each hour of input meteorology, and calculates user-selected short-term averages.

The ISCST3 model has considerable flexibility in the specification of receptor locations. The user of the model has the capability of specifying multiple receptor networks in a single run, and may also mix Cartesian grid receptor networks and polar grid receptor networks in the same run.

The ISCST3 model is appropriate for the following air dispersion applications:

- Multiple area, or point industrial source complexes;
- Rural or urban areas;
- Flat or rolling terrain;
- Transport distances less than 50 kilometers;
- One hour to annual averaging of exposure duration; and
- Continuous toxic air emissions.

The ISCST3 model includes a wide range of options for modeling air quality impacts of pollution sources, making them popular choices among the modeling community for a variety of applications.

The ISCST3 (version 3) model is used for this air dispersion modeling.

3.2 PCB EMISSION SOURCES

There are several types of PCB emission sources that could contribute to the air quality at the NBH Site. These sources can be classified into the two following categories: background emission sources and remediation emission sources. The background emission sources are the relatively long-term and consistent sources that regularly contribute some level of contaminants to the atmosphere. The identified background sources include the following:

- Harbor mudflats and inter-tidal sediments; and
- Point or area land sources with previous PCB contamination.

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All background sources contribute to the baseline air quality.

Remediation emission sources are those sources that only contribute potential emissions during periods of active remediation. For a CAD-based approach this would include the mechanical dredging operations, transport of sediment, and CAD cell disposal operation. The remediation emission sources are short-term in nature. Table 2 lists the PCB emission sources that may contribute to aerosol dispersion of contaminants during dredging and CAD activities.

3.3 SOURCE EMISSION MECHANISM AND RATE

There are three potential sources of PCB air emissions that may occur during mechanical dredging:

- the exposed dredge bucket,
- the surface of the open barge, and
- the disturbed water surface.

The contaminated sediment will be dredged by the mechanical arm bucket and dumped into an open barge. During the dredging process, PCBs may be emitted from the disturbed water surface caused by the dredging bucket. PCBs may also be emitted from exposed sediment within the dredging bucket during the transferring process from the water surface to the dump on the barge. Since the barge is open to the air, PCBs may be emitted from exposed sediments on the waiting barge during the actual dredging process.

After the open barge is filled using the mechanical dredging device, the open barge would be towed to the CAD cell location for sediment disposal. During the transport process, there may be PCBs emitted from the barge along the transport routes.

At the CAD cell location, it is assumed that the dredged sediments would be placed into the CAD cell by either a) releasing from the bottom of a split-hull scow or b) using a

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clam shell bucket. Both these methods have the potential to emit additional airborne PCBs.

The emission from each of the dredging, transport, and disposal processes will depend on the PCB concentration of the sediment and length of the exposure due to the activity.

Thibodeaux and Foster Wheeler estimated PCB emission rates for activities associated with some remediation scenario operations. The emission rates were derived based on emission calculations using sediment concentration data and field and laboratory measurements, lab experiments and testing, and theoretical calculations (Thibodeaux 1989; Foster Wheeler 2001). The emission rates were important input parameters for the air dispersion modeling to evaluate potential air impacts from remediation activities

Table 3 lists the PCB flux rates for background emission sources and remediation emission sources associated with dredging and CAD activities. The theoretical flux rates are based on sediment with a PCB concentration of 432 ppm (Thibodeaux 1989). PCB emission rates for each MU were calculated using a MU-specific PCB concentration based on a linear concentration-flux rate relationship.

3.4 METEOROLOGICAL DATA

ISCST3 uses hourly meteorological data records to define conditions for plume rise, transport, diffusion, and deposition and to estimate the concentration or deposition value for receptors. Therefore, site-specific meteorological data is important for the modeling effort.

An initial meteorological monitoring program was conducted at the NBH Site. The on-site meteorological station is located on the confined disposal facility (CDF) site (end of Sawyer Street) adjacent to the harbor. Meteorological data collected from 1996 to 1999 were processed and used in the previous air dispersion modeling (Foster Wheeler 2001).

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The on-site meteorological station was restored in 2006. The data collected at the on-site station includes wind speed and direction, temperatures at heights of 2 meters and 10 meters, relative humidity, barometric pressure, solar radiation, and precipitation. The wind speed and direction are recorded at five-minute intervals. Remaining parameters are recorded at 60-minute intervals for the year.

Figure 4 shows the data summaries of meteorological parameters in 2006, 2007, and 2008. Figure 5 shows the wind rose diagrams illustrating the wind speed and direction at the site for those three years.

3.5 DISCRETE RECEPTORS AND MODELING GRID

Discrete receptors are used in the air dispersion model to represent the air monitoring stations and sensitive residential, school, and industrial locations. The air monitoring locations used in 2008, along with the discrete receptor locations, as previously identified in the FW air dispersion study (Foster Wheeler 2001), are presented on Figure 6.

A grid system with 100 meters by 100 meters spacing is used to cover the NBH Site for modeling prediction. The grid system is used to generate model-predicted PCB concentration contours. This approach is necessary since the discrete receptors do not have either the density or distribution to construct a more precise contour map. Figure 7 shows the grid system for the NBH Site.

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4.0 SIMULATION OF DREDGING AND CAD ACTIVITIES

Air modeling based on the 2008 meteorological data was used to predict the air quality impact for the proposed dredging and CAD activities. ISC-AERMOD View version 5, an air dispersion modeling software package that incorporates the ISC3 model, was used for this modeling effort (Lake Environmental Software 2006).

All the modeling runs conducted are summarized in Appendix A and the modeling input and output files for these runs are provided on a compact disc (CD) in Appendix B.

4.1 SOURCE-SPECIFIC EMISSION REPRESENTATION AND APPLIED EMISSION RATE

As discussed in Section 3.2, the PCB emission sources include the following:

- Harbor mudflats and inter-tidal sediments;
- Point or area land sources with previous PCB contamination from former operations; and
- Dredging operations and associated transport and disposal processes.

Emission rates from these sources can be constant, intermittent, or occur only once. The point or area land sources are assumed to be constant, continuous sources. The mudflats are intermittent sources, and are only exposed during low tide periods. Dredging and disposal result in potential point, line, and area sources for which emissions only occur during the hours of the dredging, transport, and disposal activities.

The ISC3 model source input allows great flexibility in the representation of the sources. The ISC3 model provides many source emission options by using an emission factor and/or variable emission rate in the source term. Emission factors or rates may be specified for either individual sources or groups of sources. The factors may vary for different time and wind scales, as a function of season, month, and hour of day, and by wind speed and stability category.

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The total emission from a particular source is a function of emission flux rate and emission duration for the modeled period. Since the ISCST3 model is a steady-state Gaussian plume model that incorporates either hourly or periodic meteorological data for its predictions, emission factors are used to account for the total emission for a specific period modeled for a one-time dredge source. The emission factor for a single dredging operation occurring over a specific area and duration is derived as follows:

Emission Mass Released (g) = Flux rate in grams per square meter-hour (g/m^2-h) * Area in square meters (m^2) * Emission duration in hours (h) * Emission factor

Emission factor = Emission duration/Source duration applied in the modeling

For example, if the one day dredge area is used as a continuous source for 24 hour simulation time (source duration applied in the modeling) and the dredge emission hours are only 12 hours, the emission factor is 0.50 (12/24) to derive the dredging day average concentration. However, if the same 12 hour dredging source is used as a continuous source for an annual simulation period in the model, the emission factor is 0.00139 [12/(24*30*12)] to calculate the annual average concentration.

Table 3 shows the emission duration assumed for the processes used for modeling in terms of total hours for each particular location. For each dredging location, a 12-hour emission from water is assumed to represent the dredging hour for the area. For the exposed sediment in a dredging bucket, a one-hour emission is assumed as multiple sediment exposures from multiple buckets for a particular location. The open barge is assumed to have a two-hour emission time for each location for the whole footprint of the dredged area. In reality, the barge will likely be in many locations within the footprint during the dredging operation with longer emission time. However, using the whole dredging area as an emission source for the barge eliminates the specification of the locations and provides a more reliable yearly average estimate. All the durations used for the dredging activities are likely longer than actual process duration and will result in more conservative (higher) estimation.

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For barge transport, the emission duration will be extremely short along the transport paths. For the Upper Harbor, the barge size is assumed to be 1,000 cy and the barge will take about one hour from lower Upper Harbor MUs to the CAD cell. For the Lower Harbor dredging, a 5,000 cy barge is assumed. The total emission durations along the transport paths then are calculated based on the speed and numbers of trips the barges make over the project duration.

For the CAD cell disposal, each dump by the barge only occurs in a particular location and emission duration is very short. For the dredging season emission, a 16-hour and a 12-hour emission duration is assumed for each dump during the two dredging seasons, respectively. Similar to open barge, the whole CAD cell footprint is used as continuous emission sources for the dredging season. Using the whole CAD cell area as an emission source for the disposal will eliminate the specification of the locations and provide a more reliable and conservative yearly average estimate.

For the dredging and CAD activity modeling, the MU-specific emission flux rates for all emission processes are calculated based on the average PCB concentrations in the sediment as shown in Table 4. For the transport and CAD disposal process, the composite concentrations for the MUs for each year are used to calculate the emission flux rates.

The remediation activities are assumed to be 180 and 156 days for the two years of dredging and CAD placement. For the first year, a May to October dredging and disposal season is assumed. The dredging MU and CAD sources are assumed to be continuous area sources for the entire remediation period (180 days). For the second year, a June to October dredging and operation season is assumed (156 days) for the respective dredging MUs and CAD site.

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The whole dredging area for each year is used as a continuous emission source for the dredging season for the annual average PCB calculation. The applicable emission rates for dredging at each MU and associated transport and CAD disposal activities are calculated and listed in (Table 4).

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For annual average emission calculations, the remaining intermittent yearly emission from the mud flats at the lower Upper Harbor is modeled using an hourly intermittent source with the full emission rate occurring in two periods (corresponding with the low tide) per day (12 am to 2 pm and 12 pm to 2 am for a four-hour-per-day exposure scenario). It is assumed that all of the contaminated mudflats will be removed during the first year of the operation and they will only contribute to air emission during the first half of that year. It should be noted that this assumption is a deviation from the Alternative #4 Hybrid assumption for mudflat and wetland remediation over Years 4 and 5. Therefore, in addition to the hour emission periods for the mudflats, a 0.5 emission factor is used to represent the total emission for the whole year. This is done because ISC3 does not define hourly and monthly at the same time for a source. The on-land Aerovox source is assumed to be present for the simulation. However, it has no impact to the air quality of the Lower Harbor area.

4.2 CAD CELL DISPOSAL AND DREDGING SIMULATION

The modeling runs were set up to provide an estimate of annual average PCB concentrations in air from the dredging and CAD contributions and the combined background and dredging sources for each of the two years of operation.

Isocontours of the model-predicted total annual average PCB concentration at the NBH Site (i.e., including background sources) for the first year are shown in Figure 8. The maximum concentration from all dredging and CAD sources (i.e., excluding the on-land Aerovox site) occurs near the mudflats of the dredging area (MU-25 to MU-30) with a high of about 60 nanograms per cubic meter (ng/m^3). The contribution from the dredging, transporting, and disposal activities (i.e., not including background sources) is shown in the isocontours in Figure 9. The maximum concentration at the dredging area from dredging activities is less than 10 ng/m^3. The resulting concentration from CAD cell disposal is even smaller, less than 4 ng/m^3. Along the transport paths, the predicted PCB concentration is less then 0.25 ng/m^3. The on-land Aerovox contamination is not related to dredging operations.

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Isocontours of the model-predicted total annual average PCB concentration at the NBH Site (i.e., including background sources) for the second year is shown in Figure 10. The maximum concentration (excluding the on-land Aerovox site) occurs near the center of the dredging area (MU-31 and MU-32) with a maximum concentration less than 10 ng/m^3. Because the background Upper Harbor mudflat sources are assumed to have been remediated in Year 1 (with the exception of the on-land Aerovox site) and none exist in the Lower Harbor, the PCB source is solely from the dredging, transporting, and disposal activities. The detailed distribution for the PCB concentration from dredging and CAD disposal in the second year (i.e., not including background sources) is shown in Figure 11.

The model predicts that the second year will have lower concentrations than the first year because of the lower PCB concentrations in the dredged sediments and a shorter remediation time (156 days vs. 180 days).

Table 5 presents the model-predicted average PCB concentrations for all the discrete receptor locations (Figure 6) for the specific year. The predicted annual average concentrations due to emissions from the dredging and CAD disposal operations are also presented in Table 5.

4.3 CONCLUSIONS

Results of the air dispersion modeling of the proposed dredging and CAD activities indicate that the maximum annual impacts from the planned operations, even with background sources included, would remain far below the risk-based ambient air concentrations developed for the NBH Site at any of the locations evaluated, even given the large areas planned for dredging. The allowable ambient PCB concentration limits are 409, 639, and 894 ng/m^3 for child, adult resident, and commercial worker; respectively, for a 10-year exposure duration scenario (Foster Wheeler 2001).

These air dispersion modeling results also point to the significant role that unremediated PCB-contaminated mudflats have on local airborne PCB levels. These unremediated

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sources are shown to be a larger contributor of airborne PCBs than the proposed dredging and CAD cell disposal operations. Any remedial approach that accelerates the overall schedule of the Superfund harbor cleanup will thus have a positive impact on reducing background airborne PCB levels.

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Results of the air dispersion modeling of the dredging and CAD activities can be used to provide the basis for conducting risk analysis and exposure calculations. The modeling results can also be used to derive dispersion factors for use in the air quality budgeting exposure plan. Dispersion factors provide a convenient method to estimate the targeted PCB concentrations at any selected location using measured field data from a known monitoring station for the same time period. Dispersion factors between a monitoring station and a representative receptor location are defined as the ratio of the projected annual average total PCB concentration at the monitoring station to the predicted annual average total PCB concentration at the target receptor location. ¶

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FIGURES

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TABLES

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APPENDIX A

Modeled Scenarios

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APPENDIX B

Modeling Input and Output Files

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